

What is Claimed Is:

1. A method of forming a thin film of magnesium boride on a silicon substrate, the method comprising:

introducing a substrate containing silicon into a chamber;

physically generating vapor from at least one source of magnesium, which is within the chamber with the substrate;

introducing at least one boron precursor to the chamber, which combines with the vapor from the at least one source of magnesium to form a thin film of magnesium boride on the substrate, substantially free of magnesium-silicon contaminates between the substrate and the magnesium boride film.

2. The method of claim 1, comprising introducing a carrier gas to the chamber prior to, during, or after introducing the boron precursor.

3. The method of claim 2, wherein the carrier gas contains hydrogen and/or nitrogen.

4. The method of claim 1, comprising maintaining a pressure of about 0.1 to about 100 Torr in the chamber during formation of the magnesium boride film on the substrate.

5. The method of claim 1, comprising heating the at least one source of magnesium to a temperature of about 650 K to about 1300 K to physically generate vapor of the at least one source of magnesium.

6. The method of claim 1, comprising maintaining a distance of no less than several inches between the substrate and the at least one source of magnesium while physically generating vapor from the at least one source of magnesium.

7. The method of claim 1, wherein the boron precursor is boron trichloride, boron tribromide, diborane, trimethylboron, boron trifluoride, or any combination thereof.

8. The method of claim 1, comprising maintaining a pressure of about 0.1 Torr to about 30 Torr in the chamber during formation of the magnesium boride film on the substrate.

9. The method of claim 1, wherein the pressure of the vapor is maintained within $\text{Log}(P) = -9549.5/T + 9.1$; and $\text{Log}(P) = -10142/T + 8.562$, where P represents pressure in units of Torr and T represents temperature in Kelvin.

10. The method of claim 1, comprising physically generating the vapor of the magnesium thermally, or by a pulsed laser.

11. The method of claim 1, comprising physically generating magnesium vapor from the at least one source of magnesium, and introducing a carrier gas to the chamber along with the boron precursor.

12. A method of forming a thin film of magnesium boride on a silicon substrate, the method comprising:

- introducing a silicon substrate into a chamber;
- physically generating magnesium vapor from a magnesium source by heating the magnesium source within the chamber;
- introducing diborane to the chamber; and
- forming a magnesium diboride thin film directly on the silicon substrate.

13. The method of claim 12, wherein the pressure of the magnesium vapor is maintained within about $\text{Log}(P) = -9549.5/T + 9.1$; and $\text{Log}(P) = -10142/T + 8.562$, where P represents pressure in units of Torr and T represents temperature in Kelvin (K).

14. The method of claim 13, comprising introducing a carrier gas to the chamber prior to, during, or after introducing the boron precursor.

15. The method of claim 14, forming the magnesium diboride thin film directly on the silicon substrate substantially free of any non-magnesium diboride compound between the substrate and magnesium diboride film.

16. A multilayered structure comprising the magnesium diboride film of claim 15 and the substrate.

17. A method of forming a thin film of magnesium boride on a silicon substrate, the method comprising:

- introducing a silicon substrate into a chamber;
- maintaining magnesium vapor at a magnesium partial pressure within the chamber between about $\text{Log}(P) = -9549.5/T + 9.1$ and about $\text{Log}(P) = -10142/T + 8.562$, P represents pressure in units of Torr and T represents temperature in Kelvin; and

- introducing at least one boron precursor to the chamber to combine with the magnesium vapor to form a thin film of magnesium boride on the substrate.